Claims

1. A converter for converting an intermediate frequency (IF) signal to a baseband signal, the IF signal having a center frequency of $f_0$ and bandwidth R, comprising:

a $\Sigma$-$\Delta$ A/D converter for converting the IF signal to an output signal by sampling the IF signal at a sampling rate $F_{s0}$, where $F_{s0} = f_0/N$ (N an integer) and $F_{s0} > R$;

a first band pass filter for producing an I signal, the first band pass filter including a first finite-impulse response (FIR) filter operating at a sampling rate $F_{s2}$, where $R \leq F_{s2} < F_{s0}$; and

a second band pass filter for producing a Q signal, the second band pass filter including a second FIR filter operating at the sampling rate $F_{s2}$,

such that the phases of the I and Q signals differ by 90 degrees.

2. The converter of claim 1, wherein the first and second band pass filters are designed as low pass filters having bandwidths greater than or equal to R/2 and having impulse responses, respectively, the impulse response of the low pass filter design of the first band pass filter being multiplied by a sine function having a center frequency of $f_0$, and the impulse response of the low pass filter design of the second band pass filter being multiplied by a cosine function having a center frequency of $f_0$.

3. The converter of claim 2, wherein the first and second band pass filters are designed as low pass filters using a SINC function.

4. The converter of claim 2, wherein the impulse responses of the first and second band pass filters are truncated by a conventional window function.

5. The converter of claim 4, wherein the window function is the Hamming window function.

6. A method for converting an intermediate frequency (IF) signal to a baseband signal, the IF signal having a center frequency of $f_0$ and bandwidth R, comprising the steps of:

a) converting the IF signal to an output signal by using a $\Sigma$-$\Delta$ A/D converter for sampling the IF signal at a sampling rate $F_{s0}$, where $F_{s0} = f_0/N$ (N an integer) and $F_{s0} > R$;

b) producing an I signal by passing the output signal through a first band pass filter including a first finite-impulse response (FIR) filter operating at a sampling rate $F_{s2}$, where $R \leq F_{s2} < F_{s0}$; and

c) producing a Q signal by passing the output signal through a second band pass filter including a second FIR filter operating at the sampling rate $F_{s2}$,

such that the phases of the I and Q signals differ by 90 degrees.

7. The method of claim 6, wherein step b) includes designing the first band pass filter as a low pass filter having a bandwidth greater than or equal to R/2 and having a first impulse response that is multiplied by a sine function having a center frequency of $f_0$, and

step c) includes designing the second band pass filter as a low pass filter having a bandwidth greater than or equal to R/2 and having a second impulse response that is multiplied by a cosine function having a center frequency of $f_0$.

8. The method of claim 7, wherein steps b) and c) further include respectively designing the first and second band pass filters as low pass filters using a SINC function.

9. The method of claim 7, wherein steps b) and c) further include respectively truncating the impulse responses of the first and second band pass filters by a conventional window function.

10. The method of claim 9, wherein steps b) and c) include respectively truncating the impulse responses of the first and second band pass filters by Hamming window functions.

11. A converter for converting an intermediate frequency (IF) signal to a baseband signal, the IF signal having a center frequency of $f_0$ and bandwidth R, comprising:

means for converting the IF signal to an output signal by using a $\Sigma$-$\Delta$ A/D converter for sampling the IF signal at a sampling rate $F_{s0}$, where $F_{s0} = f_0/N$ (N an integer) and $F_{s0} > R$;

means for producing an I signal by passing the output signal through a first band pass filter including a first finite-impulse response (FIR) filter operating at a sampling rate $F_{s2}$, where $R \leq F_{s2} < F_{s0}$; and

means for producing a Q signal by passing the output signal through a second band pass filter including a second FIR filter operating at the sampling rate $F_{s2}$,

such that the phases of the I and Q signals differ by 90 degrees.

12. The converter of claim 11, wherein the means for producing an I signal includes a first low pass filter having a

bandwidth greater than or equal to R/2 and having a first impulse response that is multiplied by a sine function having a center frequency of $f_0$, and

the means for producing a Q signal includes a second low pass filter having a bandwidth greater than or equal to R/2 and having a second impulse response that is multiplied by a cosine function having a center frequency of $f_0$.

13. The converter of claim 12, wherein the means for producing an I signal and for producing a Q signal further include low pass filters using a SINC function.

14. The converter of claim 12, wherein the means for producing an I signal and for producing a Q signal further include respectively means for truncating the impulse responses of the first and second band pass filters by a conventional window function.

15. The converter of claim 14, wherein the means for producing an I signal and for producing a Q signal respectively includes means for truncating the impulse responses of the first and second band pass filters by Hamming window functions.